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EFFECTS OF BUFORD DAM ON THE CHATTAHOOCHEE RIVER WATER QUALITY

By

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With the completion of Buford Dam, the upper reaches of the Chattahoochee River became a regulated river. The effects of the dam on the quantity of water could be easily estimated, however, the effect on the quality of the water was an uncertainty. The need for an investigation of the effect of Buford Dam on the water quality has been shown by recent papers (1,2,3) published on the water quality of the discharge from other large multipurpose reservoirs. These papers have indicated that various undesirable characteristics have appeared along with the increase in minimum rates of flow. Several of the undesirable factors are the very low holiday discharges, low dissolved oxygen, and the presence of iron and manganese at times. A desirable effect can be the decrease in temperature when the water from the low levels of the lake is used for power generation.

A study was initiated to show changes of water quality with respect to seasonal variations and changes occurring within a mass of water as it traveled downstream from the point of discharge. In this study of the discharge, the method of operation for power generation at the dam had to be considered. The main turbines are operated for peaking capacity purposes, which means they will operate only through the middle of the day. In order to maintain a minimum stream flow of at least 295 cubic feet per second (cfs), a small turbine is operated at all other times. The peaking discharge was selected for study in this investigation. Observations were made to cover the peaking period from minimum flow to maximum flow and back to the minimum flow. To give a complete picture of the progressive changes downstream, the observations at the selected points downstream followed the "same" water. As the downstream flow is in a highly unsteady state due to the celerity of the wave being higher than the actual velocity of the water and storage effects, the main discharge reached each sampling point progressively later with respect to the hour of the day and with a reduced peak of discharge. Both of these factors affected the sampling and calculations.

An initial sampling run was made using Stations No. 1, 2, and 3, as shown on the map in Figure I. The distance from the power house to Station 1 was 0.22 miles, to Station 2 was 4.73 miles, and to Station 3 was 8.48 miles. The rate of discharge was determined from flow records at the power house. The following items were measured and recorded every 30 minutes: (1) dissolved oxygen, (2) temperature, (3) pH at Stations 1 and 3, (4) relative water surface level. From this information, general characteristics of the power wave were plotted (Graphs 1, 2, 3). The curves indicated the need for an adjustment of the sampling periods and additional stations.

Two more sampling stations selected for the second sampling run included No. 4 which was 17.55 miles below the power house, and No. 5, which was 31.03 miles below the power house. Stations 4 and 5 have U.S.G.S. gaging stations conveniently located near them. The stations and general area

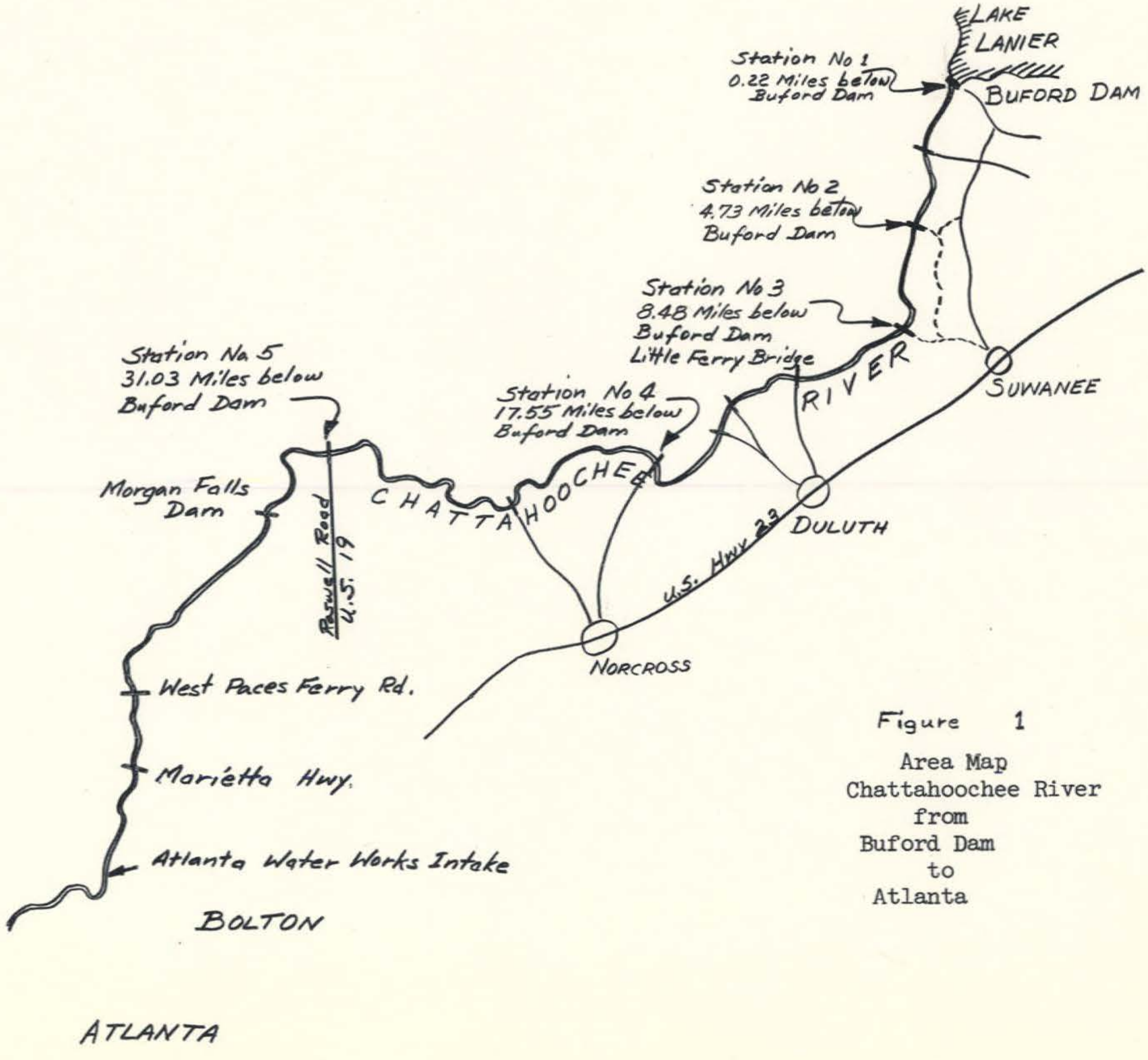


Figure 1

Area Map
Chattahoochee River
from
Buford Dam
to
Atlanta

can be seen on the map of the area, as shown in Figure I. The river has an average fall of 2.08 feet per mile within this total distance and varies only from 1.81 feet per mile to 2.37 feet per mile between individual stations.

The same information was collected on the second run with the addition of hourly B.O.D. samples at all stations, iron and manganese samples at Stations No. 1, 2, and 3, and readings of the U.S.G.S. river gages at Stations 4 and 5. In conjunction with this work on the river, samples were collected in Buford reservoir (Lake Lanier) just above the penstocks of the power house. The samples were collected at various depth from the surface to the bottom of the reservoir, a depth of 140 to 160 feet. The pH, D.O., B.O.D., temperatures, and iron and manganese content were determined on the lake samples.

After the second run, weekly samples were collected in the tail race below the power house and in the reservoir. The results of these samples controlled the possibility of making a third complete power discharge study. No significant changes were recorded in the water being discharged as a D.O. of better than 4.5 ppm was found at all times in the tail race during the month of August.

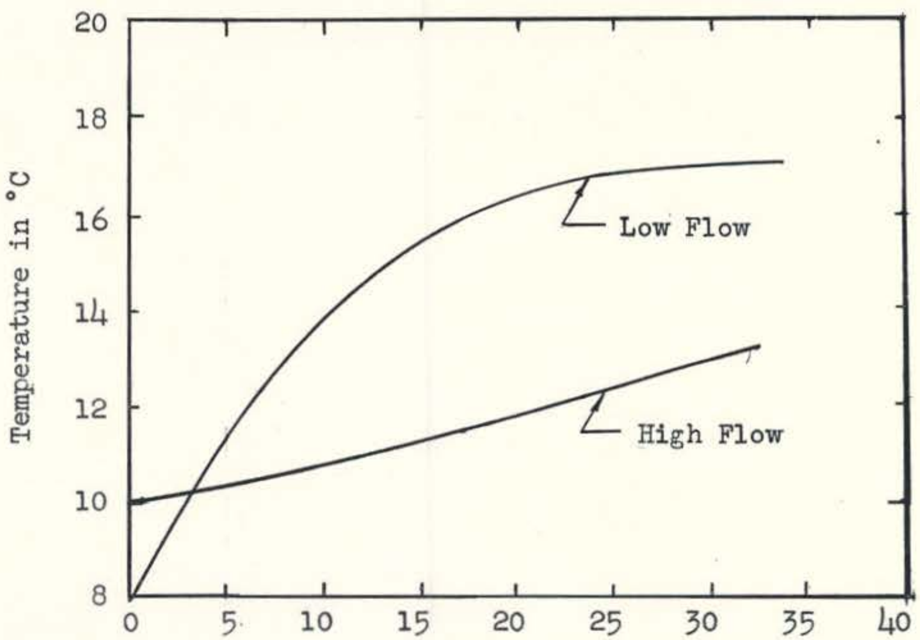
DISCUSSION AND RESULTS

Temperature - The temperature of the water being discharged at the time of this study was between 8° C. and 10° C. This was a difference of nearly 20° C. from the lake surface water temperature of 29° C. It was recognized that the temperature of the river before the construction of the dam would have been between the normal ground water temperature of 15° C. and the 29° C. This would still be a change of 8° to 15° C. which can probably be attributed in some part to the extreme cold weather of the previous winter.

The change of temperature with respect to distance from the dam was a function of the discharge rate and other factors. The effect of the rate of flow is shown in Figure II. At low flows, the initial rate of change for the first two stations approaches a 0.65° C. rise per mile and has an average change of 0.3° C. rise per mile through the total region studied. At high flows the rate of increase is much less as would be expected because of the shorter period of time and the smaller surface of air contact per unit volume of water. The initial change for the first two stations at high flows varied from 0.1° C. to 0.5° C. per mile while the average change varied from 0.16° C. to 0.13° C. per mile over the five stations. The 0.13° C. covers a period of night flow and corresponds to a 4° C. rise in 31 miles. These small changes of temperature with respect to distance were very significant in that they made possible the calculation of the approximate actual water velocity as distinguished from the wave velocity. Similar work has been done using dyes and conductivity (4).

The variations in temperature of the water passing a given point can be used to approximate the actual water velocity when considered with the increase in temperature of a mass of water flowing downstream. The rate of temperature rise as the water flowed downstream was greatly reduced by the increased flow as indicated by the data which shows an increase in temperature at the point of discharge as the flow was increased, however, at Station 2 the temperature drops as flow increased. By relating these changes

FIGURE II



Distance from Buford Dam in miles

in temperature to the flow time involved Table I shows the average values of the wave movement in comparison to the actual water velocity.

TABLE I

ESTIMATED TIME OF WAVE MOVEMENT AND ACTUAL WATER FLOW

	Wave Movement			Actual Water Flow		
	Time of Rise		Velocity	Time of Temp Change		Velocity
	Peak	Total		Between Stations	Total	
Station 1						
	$1\frac{1}{2}$ hrs	$1\frac{1}{2}$ hrs	3.01mph	$2\frac{1}{2}$ hrs	$2\frac{1}{2}$ hrs	1.81mph
Station 2						
	$1\frac{1}{2}$ "	3 "	2.50 "	2 "	$4\frac{1}{2}$ "	1.87 "
Station 3						
	$3\frac{1}{2}$ "	$6\frac{1}{2}$ "	2.58 "	5 "	$9\frac{1}{2}$ "	1.81 "
Station 4						
	6 "	$12\frac{1}{2}$ "	2.25 "	$9\frac{1}{2}$ "	19 "	1.41 "
Station 5						

In reference to Chezy's equation modified for the velocity of the water relative to the flood wave ($V_{wave} = 3/2\ V_{actual\ water}$) (5) the values of Table I check the equation within 10 to 15 per cent. This means that these observations are in rather close agreement with the theoretical velocity when the basic assumption of a constant velocity of wave translation is made by noting the correlation of the slugs of constant temperature at thirty minute intervals with the river stages.

Further effects of temperature will be discussed under Dissolved Oxygen.

Dissolved Oxygen - The dissolved oxygen content of the power discharge was higher than the literature indicated that it might be. Churchill (6) shows the dissolved oxygen content in TVA reservoirs at similar depths and times of the year to be less than 2 ppm and with dissolved oxygen contents in the tail race during high power discharge of less than 1 ppm. The dissolved oxygen of the discharge at Buford Dam varied from 5 ppm at minimum discharge to 6.5 ppm at high discharge. The samples collected on the bottom of the reservoir above the penstocks had a dissolved oxygen content of 3.5 to 4.6 ppm. This corresponds to 33 to 43 per cent of the saturation value at the 10° C. temperature of the water at that level. The high dissolved oxygen in the lake provided the additional dissolved oxygen in the discharge. The residual oxygen saturation values of the power discharge varied from 43 per cent at low flows to 56 per cent saturation at high flows. While the dissolved oxygen during the time of the study remained unusually high, this may be due in part to the lack of B.O.D. exertion caused by the low temperatures. There would be no B.O.D. from nitrification at the temperature of 10° C. The low temperatures at the bottom of the lake may be due to the severity of the past winter.

As the water moved downstream, the dissolved oxygen increased from station to station. At low river flows, the rate of increase was initially high but gradually decreased, as shown in Table II. The reduction of the

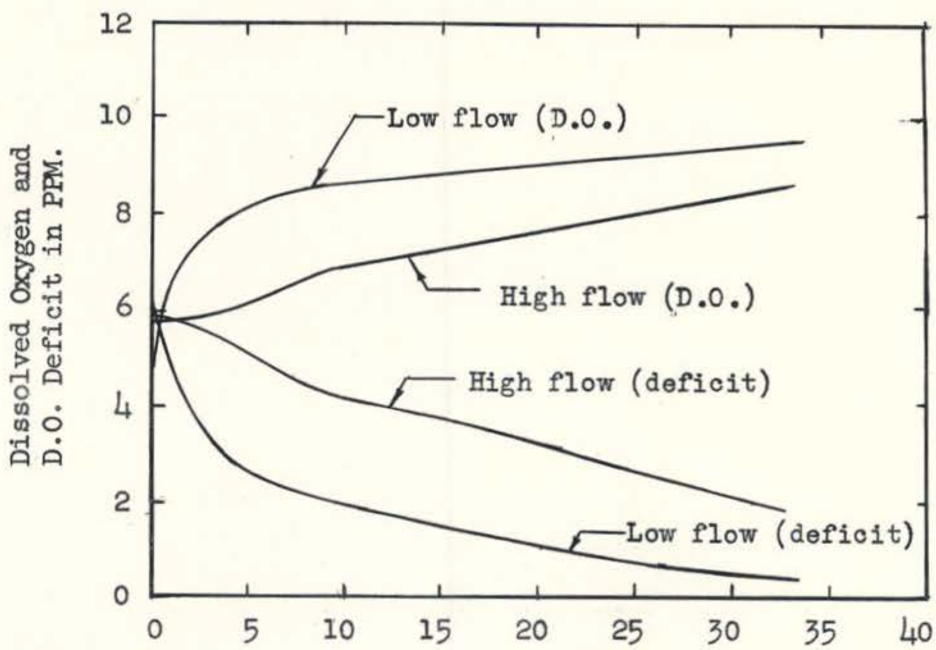
TABLE II

REAERATION CONSTANTS (k_2)

	Before Power Discharge	Peak of Power Discharge	Lower End of Discharge Wave
Station 1 – Station 2	3.99	0.19	1.16
Station 2 – Station 3	1.60	0.77	0.44
Station 3 – Station 4	1.57	0.95	0.25
Station 4 – Station 5	1.91	0.59	0.87

dissolved oxygen deficit at low flows gives a curve which is very similar to the log curve as predicted by the reduced Streeter-Phelps equation (7) for reaeration alone, as can been seen in Figure III. At high flows the rate of reaeration is reduced (see Figure III), and again a major portion of this reduction can be contributed to the faster velocity of flow and lower ratio of surface area per unit volume.

FIGURE III



Distance from Buford Dam in miles

The value of the reaeration constant, k_2, with two exceptions was several times higher than the maximum values of the 0.05 to 0.5 values as given by Babbitt (8), but corresponded very well to the values found by Churchill (9). One of the problems in the use of the Streeter equation is the time factor. In the earlier work, (10), time was usually taken in terms of whole days which was the period of conditions under investigation. In a study such as this where the time involved is a matter of hours, an examination of the basic equation

$$k_2 = \frac{\text{Log Initial DO Deficit - Log Final DO Deficit}}{\text{Time in Days}}$$

will indicate that a small change of the time values of as much as an hour (at one or two hours) will provide a relatively large change in the values of k_2. For instance, between Stations 1 and 2, at low flows, Table III indicates the relative difference in k_2 values for various values for time and temperature.

Some of the other factors contributing to very high apparent results are both the low initial BOD, the low per cent of saturation, as well as the large temperature difference between the water and air at its surface.

TABLE III

EFFECTS OF ERRORS IN TIME ON REAERATION CONSTANTS

Time of Flow (hours)	k_2(10° C.)	k_2(20° C.)
1.0	8.50	9.96
1.5	5.65	6.65
2.0	4.25	4.98
2.5	3.40	3.99
3.0	2.83	3.32
24.0	0.36	0.42

One point of interest in relation to this is that there was only a very slight rise, if any, in dissolved oxygen between Station 4 and 5 at high flows, but the deficit drop was in excess of 1.0 ppm. The curves of Figure II show an increase in temperature between these stations of as much as 2° C. at high flows which corresponds to a drop in the saturation dissolved oxygen value of almost 0.5 ppm at this temperature.

Another point of interest is that as the temperature of the water from the dam dropped the per cent saturation of dissolved oxygen decreased, but as the temperature in the river increased the per cent saturation increased with no increase in oxygen level. This is readily seen from the data in the Appendix.

From the data obtained thus far on the Chattahoochee River, little can be said about the effect of temperature on the dissolved oxygen in the waters of the hypolimnion. The tail race samples of Run 1 had an average temperature of 8.4° C. with an average D.O. of 7.4 ppm or 63 per cent saturation, while those of Run 2, fifteen days later, had an average temperature of 8.8° C. with an average D.O. of 6.0 ppm or 55 per cent saturation. This indicates a drop in dissolved oxygen saturation as the temperature increases with time, which is just the opposite of the results obtained as the water flows down the river. The apparent loss of dissolved oxygen is due to the use of oxygen in destruction of the organic matter in the stagnate waters of the hypolimnion. From a set of unpublished data obtained from the Catawba River at Rock Hill, S. C. (11) the per cent saturation of dissolved oxygen has been observed to decrease by approximately 10 per cent for every 3° C. rise in temperature above 19° C. This, however, would be dependent on the quantity of organic matter present in the lake, the rate of temperature increase, and the detention time for small lakes.

<u>Biochemical Oxygen Demand (BOD)</u> - The BOD values of the power discharge were similar to values in the hypolimnion of the reservoir during the month of July. They were all within the range of 0.5 to 1.5 ppm. There were no significant changes in the B.O.D. values except for a slight increase of the average of 1.0 ppm in the tail race to 1.5 ppm at Station 4, but this average was reduced to 1.1 ppm at Station 5.

The initial D.O. deficit at the dam would have the same affect as an immediate, chemical,completed, dissolved oxygen demand. Based on this, the population equivalent was calculated by a step intergration process based on the various flow conditions. At the dam this was equal to an equivalent of 132,000 persons, but allowing for the possibility that the original river had only 90 per cent saturation, like the surface of the reservoir, this would still be approximately 120,000. While this value does not appear to be very large, when it is realized that the plant was operating on a maximum discharge from both turbines only 2 hours during the day and limited operation over three hours, it could easily be 8 to 10 times this value for a full 24 hour operation. It is true that the minimum flows have been increased so that the overall total amount of dissolved oxygen in the river has been increased, but it is the actual concentration of dissolved oxygen on which the fish and other biota of the stream depend for their existence. This would also have an effect on the location of new industry and sewage plants immediately downstream in that there would be less dissolved oxygen in the river to help prevent their plant effluent from becoming a nuisance and while the minimum flow has been increased the river has low flow during a greater percentage of the time. For example, the stream still has a dissolved oxygen deficit equivalent to 84,000 persons at Station 4 near Norcross, Ga., and a dissolved oxygen deficit equivalent to 40,000 persons at Station 5 at the Roswell Road bridge north of Atlanta. There is the possibility that a further decrease in dissolved oxygen in Buford reservoir could greatly increase these equivalent values at the same flow. The dissolved oxygen would probably reach zero in the hypolimnion for an extended period of time following a mild winter season.

pH - There were no significant changes of the pH value with respect to the power discharge.

Iron and Manganese - The power discharge never contained more than a trace quantity of iron or manganese. The absence of detrimental quantities of iron and manganese is apparently caused by the low temperatures of the hypolimnion.

Limitations - Factors, which affect the reaeration constant and which could not be accurately evaluated, were actual mixing of the flow, the mean depth, and the roughness of the channel (12). Another limitation was the determination of the effects of darkness on the various factors. Churchill found them to be quite significant (13). It is recognized that the water quality factors measured were limited in number, and the measurement of others such as the conductivity, total alkalinity, turbidity, and E. coli would have added greatly to the study. Another limitation to this study was an increase in the flow of the downstream reaches due to various tributaries.

Conclusions - This study showed that the water being discharged from Buford Dam had a low temperature, a low B.O.D., and a dissolved oxygen saturation value of 40 per cent. The reaeration rate in the river at low flow was very high initially and decreased with distance. In the power wave the rate of reaeration was much lower initially and tended to increase with distance from the power house.

Recommendations - Based on the findings of this study, an investigation of the following items would be of great benefit:

1. A similar study to the above with samples collected at two or three stations below Morgan Falls Dam. This would indicate the additional effects of this impoundment and give a better picture of the effects of the two dams on the sewage disposal problem of the City of Atlanta.

2. A complete survey of a similar nature at a date in the future when the dissolved oxygen in Buford reservoir drops to

less than 2 ppm to show the actual critical conditions in the river.

3. A study of the river at a low flow stage would give an indication of the effects on the sewage and water treatment plants below the dam and would give an indication of the diurnal variations. This would involve a study on the weekend when peaking power is not required.

4. A study of the river at a constant high flow stage would help in understanding the difference in night and day effects on the reaeration. This could possibly be done in the fall when the reservoir is being lowered in preparation for an increase in flood storage capacity.

5. The additional measurements of other factors such as conductivity total alkalinity, turbidity, and E. coli would be helpful in the understanding of the total water quality problem

ACKNOWLEDGEMENT

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CHATTAHOOCHEE RIVER DATA

Date: July 1, 1958

Location: Below Buford Dam (0.22 miles)

Time	Temp (^{o}C)	DO ppm	DO Deficit	DO Sat.	pH	Relative Water Level	(cfs) Discharge
8:30	8½	6.1	5.6	52	6.6	0	333
9:00	8½	7.8	4.9	66½	6.7	1.8	333
9:30	8½	9.1	2.6	77½	6.8	1.8	333
10:00	8-0	9.5	2.3	80	6.7	2.3	1620
10:30	8½	6.8	5.9	58	6.8	5.4	1620
11:00	8½	7.3	4.4	62	6.8	6.7	4160
11:30	9-0	7.3	4.3	63	6.8	8.0	4160
12:00	9-0	6.9	4.7	60	6.7	7.6	7040
12:30	8½	6.5	5.2	55½	5.9*	7.1	7040
1:00	8½	6.5	5.2	55½	6.6	7.1	4300
1:30	8½	6.4	5.3	54½	6.8	6.7	4300
2:00	8½	6.5	5.2	55½	6.7	6.0	2600
2:30	8-0	8.3	3.6	70	6.7	5.2	2600
3:00	8-0	8.5	3.4	71½	6.8	3.5	2600
3:30	8-0	7.6	4.3	64	6.8	2.2	294
4:00	8-0	7.0	4.9	59	6.8	1.2	294

* Probably error in adjustment of pH meter

Bottom of Penstock-911

Elevation of intake structure is same as lake elevation - July 1, 1958
elevation: 1065.43

Fluctuation during day: Midnight, June 30- 1065.45
4:00 p.m., July 1- 1065.43

Fluctuation - Minus .02

CHATTAHOOCHEE RIVER DATA

Date: July 1, 1958

Location: 4.73 miles below Buford Dam

Time	Temp (°C)	DO ppm	DO Deficit	DO Sat.	pH	Relative Water Level
8:30	9.5	8.9	2.6	77		Same
9:00	9.8	9.0	2.4	79		Same
9:30	10.0	8.9	2.4	79		Same
10:00	10.5	8.9	2.4	77		Same
10:30	11	8.8	2.2	80	6.0	Same
11:00	11.5	8.7	2.3	79		Up 6 "
11:30	11.0	8.2	2.8	75		Up 15"
12:00	10	8.8	2.5	78		3½'
12:30	10	7.6	3.7	67		4½'
1:00	10	7.4	3.9	65		4½'
1:30	10	7.4	3.9	65		4½'
2:00	10	7.4	3.9	65		4½'
2:30	10	7.4	3.9	65		5 '
3:00	10.5	7.2	4.1	64		4½'
3:30	10	7.1	4.1	63		4½'
4:00	10	7.1	4.2	63		4 '
4:30	10	7.0	4.3	62		3½'
5:00	10.5	7.2	4.1	64	6.8	2½'
5:30	10.5	7.5	3.8	66	6.8	2 '
6:00	10.5	8.0	3.3	71	6.5	1½'
6:30	10.5	8.3	3.0	73	6.5	1½'
7:00	10.0	8.7	2.6	77	6.5	1 '

CHATTAHOOCHEE RIVER DATA

Date: July 1, 1958

Location: Little Ferry Bridge Mile 339.84 - 10 Miles Below Buford Dam

Time	Temp (°C)	DO ppm	DO Deficit	DO Sat.	pH	Relative Water Level	Appearance
12:00	13	10.0	0.6	94	6.6	0	Clear
12:30	13	9.7	0.9	92	7.1	6 "	Clear
1:00	13	9.3	1.3	88	7.6	24"	Turbid (sample sandy)
1:30	11	8.5	2.5	77	7.2	50"	"
2:00	10½	9.0	2.3	80	7.0	60"	"
2:30	10½	8.2	3.1	73	7.4	70"	"
3:00	10	8.0	3.3	71	6.9	75"	Clearing up
3:30	11	8.1	2.9	73	7.2	75"	
4:00	10½	8.1	3.2	72	6.9	72"	
4:30	10½	8.1	3.2	72	6.9	68"	
5:00	10½	7.4	3.9	65	7.1	64"	
6:00	11	8.3	2.7	75	7.2	60"	
6:30	10½	8.1	3.2	72	7.4	54"	
7:30	10	8.0	3.3	71	6.9	36"	
8:00	10½	8.0	3.3	71	7.2	24"	
8:30	11	8.1	2.9	73	6.8	24"	

CHATTAHOOCHEE RIVER DATA

Date: July 15, 1958

Location: Station 1, 0.22 miles below Buford Dam

Time	Temp (°C)	DO ppm	DO Deficit	DO Sat.	pH	Relative Water Level	(cfs) Discharge
8:00	-	-	-	-	-	-	331
9:00	8.0	4.9	7.0	41	6.6	.3	331
9:30	8.0	5.1	6.8	43	6.6	.7	331
10:00	8.0	5.2	6.7	44	6.5	.7 to 4.0	3656
10:30	9.0	6.5	5.1	55	6.6	5.0	3656
11:00	9.0	7.0	4.6	60	6.6	6.5 to 8.0	8181
11:30	9.5	5.7	5.8	49	6.6	10.0	8181
12:00	10.0	5.9	5.4	52	6.6	10.5	3614
12:30	9.0	6.3	5.3	54	6.5	8.6	3614
1:00	9.0	6.5	5.1	56	6.5	6.7	3614
1:30	9.0	6.4	5.2	55	6.5	4.5	3614
2:00	8.5	5.6	6.1	48	6.5	4.0	334
2:30	8.5	5.6	6.1	48	6.6	2.4	334
3:00	8.5	5.6	6.1	48	6.6	1.8	334
3:30	8.5	5.4	6.3	46	6.6	1.5	334
4:00	8.0	5.7	4.2	45	6.5	1.0	334

CHATTAHOOCHEE RIVER DATA

Date: July 15, 1958

Location: Station 2, 4.73 miles below Buford Dam

		DO					Relative	
Time	Temp (°C)	ppm	Deficit	Sat.	BOD	pH	Water Level	Remarks
9:00	12.5	8.0	2.7	75	1.2	6.6	0.0	Turbid
9:30	11	8.0	3.0	73		7.0	0.0	"
10:00	11	8.1	2.9	74	1.4	6.9	0.0	"
10:30	11	8.1	2.9	74		7.0	0.0	"
11:00	11	7.8	8.2	71	1.3	6.7	0.0	"
11:30	11	7.7	3.3	70		6.5	0.5	"
12:00	11	7.2	3.8	66	1.4	6.7	3.4	Muddy
12:30	10	7.3	4.0	65		6.4	5.3	"
1:00	10.5	6.6	4.9	59	1.1	6.7	6.1	"
1:30	10.5	6.0	5.3	54		6.6	6.4	"
2:00	11	6.2	4.8	56	1.1	6.8	6.2	"
2:30	11	6.1	4.9	55		6.6	5.2	"
3:00	12	6.4	4.4	60		6.7	4.4	"
3:30	11.5	6.4	4.5	59		6.9	3.7	"
4:00	12	6.7	4.1	62	0.8	6.3	3.2	"
4:30	11	7.1	3.9	65		6.6	2.7	Turbid
5:00	11.5	7.3	3.6	67		6.8	2.0	"
5:30	12	7.3	3.5	68		6.9	1.4	"
6:00	12	7.3	3.5	68	1.9	6.6	1.2	"
6:30	12	7.6	3.2	71		6.8	1.1	"
7:00	12.5	7.9	2.8	74	1.7	6.8	0.8	"

CHATTAHOOCHEE RIVER DATA

Date: July 15, 1958

Location: Station 3, 8.48 miles below Buford Dam

Time	Temp (°C)	DO. ppm	DO. Deficit	DO. Sat	BOD	pH	Relative Water Level
12:00	13	8.3	2.4	78	0.6	6.6	0.0
12:30	12	8.6	2.2	80		6.6	0.0
1:00	13	8.9	1.8	84	1.2	6.7	0.3
1:30	12	8.5	2.3	79		6.6	3.1
2:00	11	7.2	3.9	65	1.1	6.5	4.3
2:30	10	7.1	4.2	63		6.5	4.9
3:00	10.5	6.9	4.3	62	0.7	6.5	5.1
3:30	10.5	6.8	4.4	61		6.4	5.0
4:00	12	6.5	4.3	60	0.9	6.5	4.3
4:30	12	6.6	4.2	61		6.4	3.9
5:00	11	6.7	4.7	60	0.8	6.1	3.4
5:30	11	6.8	4.3	61		6.2	2.9
6:00	12	6.9	3.8	64	0.6	6.3	2.1
6:30	11.5	7.1	3.9	64		6.3	1.6
7:00	11.5	7.2	3.8	65	1.6	6.5	1.3
7:30	12	7.4	3.4	69		6.4	1.2
8:00	12	7.5	3.3	69	0.8	6.2	0.8
8:30	12	7.7	3.1	71		6.2	0.6
9:00	12	8.0	2.8	74	1.2	6.2	0.2
9:30	12	8.0	2.8	74		6.4	
10:00	12	8.2	2.6	76	1.0	6.3	
10:30	12	8.2	2.6	76		6.3	
11:00	12	8.2	2.6	76	1.0	6.4	

CHATTAHOOCHEE RIVER DATA

Date: July 15 and 16, 1958

Location: Station 4, 17.55 Miles below Buford Dam

Time	Temp (°C)	DO ppm	DO Deficit	DO Sat	BOD	pH	Water Level	(cfs) Discharge
1:00p.m.	16	8.9	1.1	89	2.3	-	1.62	517
1:30	16	8.8	1.2	88			1.62	517
2:00	16	8.8	1.2	88	1.4		1.62	517
2:30	16	8.8	1.2	88			1.62	517
3:00	16	8.9	1.1	89	1.6		1.62	517
3:30	16	8.8	1.2	88			1.62	517
4:00	16	8.8	1.2	88	1.8		1.66	542
4:30	16	8.6	1.4	86			2.48	1230
5:00	16½	8.6	1.2	88	2.4		3.38	1960
5:30	15	8.6	1.6	84			4.02	2540
6:00	15	8.6	1.6	84	1.1		4.24	2740
6:30	14½	8.5	1.8	83			4.55	3020
7:00	13½	8.5	2.0	81	1.6		4.52	3000
7:30	12½	8.3	2.4	78			4.50	2980
8:00	11½	8.1	2.9	74	1.4		4.47	2950
8:30	11½	8.1	2.9	74			4.22	2720
9:00	11½	7.9	3.1	72	1.5		4.08	2600
9:30	11½	7.8	3.2	71			3.88	2400
10:00	12	7.3	3.5	68	0.6		3.71	2230
10:30	12	7.4	3.4	69			3.36	1940
11:00	12	7.4	3.4	69	0.8		3.22	1830
11:30	12	7.4	3.4	69			3.04	1680
12:00	12	7.5	3.3	69	1.0		2.88	1550
12:30	12	7.5	3.3	69			2.72	1430
1:00	12½	7.7	3.0	71	2.7		2.60	1330
1:30	13	7.7	2.9	73			2.47	1150
2:00	12	7.7	3.1	71	0.7		2.35	1130
2:30	12.5	7.8	2.9	73			2.25	1050
3:00	13	8.0	2.6	76	0.5		2.17	990
3:30	12½	8.1	2.6	76			2.08	910
4:00	13	8.0	2.6	76	0.8		1.99	842
4:30	13	8.3	2.3	78			1.94	805
5:00	13	8.3	2.3	78	0.7		1.89	768

CHATTAHOOCHEE RIVER DATA

Date: July 15 and 16, 1958

Location: Station 5, 31.03 miles below Buford Dam

Time	Temp (°C)	DO ppm	DO Deficit	DO Sat	BOD	pH	Relative Water Level	(cfs) Discharge
3:30p.m.	17	9.4	0.3	97	-	-	-1.0	-
4:00	17.5	9.4	0.2	98	1.3	-	-1.0	574
4:30	17.0	9.4	0.3	97			-1.0	
5:00	17.0	9.4	0.3	97	1.2		-1.0	560
5:30	17.0	9.5	0.2	98			-1.0	
6:00	17.0	9.5	0.2	98	1.3		-1.0	524
6:30	17.0	9.4	0.3	97			-1.0	
7:00	17.0	9.3	0.4	96	1.2		-1.0	512
7:30	17.0	9.1	0.6	94			-1.0	
8:00	16.5	9.1	0.7	93	0.9		-1.0	506
8:30	16.5	8.9	0.9	91			-1.0	
9:00	16.0	8.9	1.1	89	1.2		-1.0	500
9:30	16.5	8.9	0.9	91			-1.0	
10:00	16.5	8.5	1.3	87	1.3		-1.0	560
10:30	17.0	8.5	1.2	88			0	
11:00	17.0	8.5	1.2	88	1.0		0.5	1150
11:30	17.0	8.5	1.2	88			0.7	
12:00	17.0	8.5	1.2	88	1.6		0.7	1750
12:30	17.0	8.5	1.2	88			0.8	
1:00	17.0	8.5	1.2	88	1.1		0.8	2080
1:30	17.0	8.5	1.2	88			0.8	
2:00	17.0	8.3	1.4	86	1.2	6.6	0.8	2130
2:30	17.0	8.5	1.2	88			0.8	
3:00	16.0	8.5	1.5	85	1.1		0.8	2040
3:30	15.5	8.5	1.6	84			0.8	
4:00	15.0	8.6	1.6	84	1.0		0.8	1870
4:30	14.0	8.6	1.8	83			0.7	
5:00	14.0	8.6	1.8	83			0.0	1670
5:30	13.5	8.5	2.0	81			0.0	
6:00	14.0	8.7	1.7	84	0.9		-0.2	1470
6:30	13.0	8.7	1.9	82		6.7	-0.2	
7:00	13.0	8.8	1.8	83	1.2	6.8	-0.3	1270
7:30	12.5	8.9	1.8	83		6.7	-0.7	
8:00	13.5	8.9	1.6	85	0.9	6.9	-0.7	1110
8:30	13.0	8.9	1.7	84		6.8	-0.7	
9:00	13.5	8.9	1.6	85	0.8	6.8	-0.7	990
9:30	13.5	9.0	1.5	86		6.7	-0.8	
10:00	14.0	9.1	1.3	88	1.3	6.6	-0.8	875
10:30	14.0	9.2	1.2	88		6.6	-0.8	
11:00	15.5	9.2	0.9	91	1.2	6.6	-0.9	790
11:30	14.5	9.3	0.9	91			-1.0	
12:00	-	-	-	-				735

LAKE LANIER DATA

Date: July 3, 1958 - 3:00 p.m.

Location: Above Buford Dam Penstocks

Depth ft.	Temp (°C)	DO ppm	% Sat	BOD ppm	pH
0	29	7.4	95	1.1	7.7
8	28	7.4	93	1.1	7.4
16	27	7.5	93	0.0	7.6
20	25	7.5	90	0.7	7.8
24	21.5	7.5	84	0.7	7.6
32	20	6.5	71	0.5	7.6
40	19	6.6	71	0.4	7.6
48	18	6.5	68	0.0	7.6
64	16	6.3	63	0.3	7.6
80	15	6.2	61	0.5	7.7
100	14	6.2	60	0.2	7.6
120	13	-	-	-	7.6
140	13	5.6	53	0.0	7.6
150	13	4.6	43	-	7.8

150' Depth was on the bottom

At this depth Mn = 0.70 ppm
Fe = 1.0
Thermocline @ 20-24 ft. depth

LAKE LANIER DATA

Date: July 12, 1958

Location: Above Buford Dam Penstocks

Depth ft.	Temp (°C)	DO ppm	DO Deficit	DO Sat	BOD ppm	pH	Fe ppm	Mn ppm	Remarks
0	27	7.1	0.7	91	0.7	8.0			
25.	21	6.6	2.9	65	0.9	6.8	-	+	
50	17	6.1	3.3	62	0.4	6.8	-	+	
75	16	6.0	3.7	61	3.6	6.8	+	1.0	Hit bottom
100	15	5.6	4.1	56	0.6	6.9	-	0.3	on channel
125	13	4.8	4.4	55	1.4	6.6	+	0.3	side
160	13	3.5	5.8	43	1.5	6.6	+	0.5	

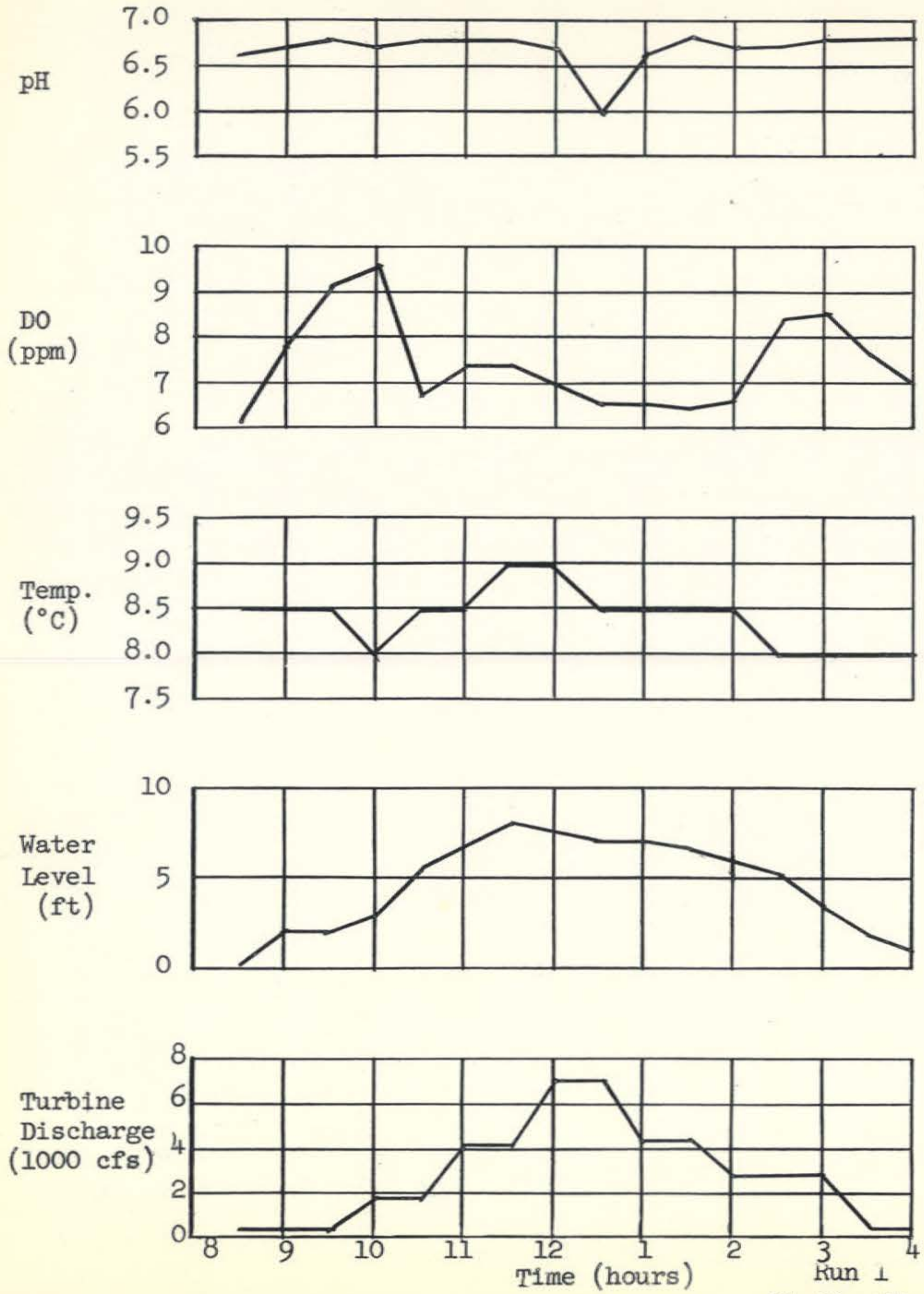
Note: Mn + samples are less than 0.05 ppm
Fe + Samples are less than 0.2 ppm

LAKE LANIER DATA

Date: July 29, 1958

Location: Above Buford Dam Penstocks

Depth-ft.	Temp(^{o}C)	DO ppm	DO Deficit	DO Sat	BOD	pH	Remarks
Surface	29	7.0	1.0.	88	0.5	8.2	
20	27	5.2	2.3	73	0.5	7.8	
30	22	5.5	3.6	63	2.1	7.9	
45	19-$\frac{1}{2}$	5.6	4.0	60	0.7	7.4	
65	18-$\frac{1}{2}$	5.3	4.6	55	0.4	7.8	
90	17	5.3	5.8	45	1.0	7.6	Hit trees
140	15	4.4	7.1	33	1.0	7.4	Bottom

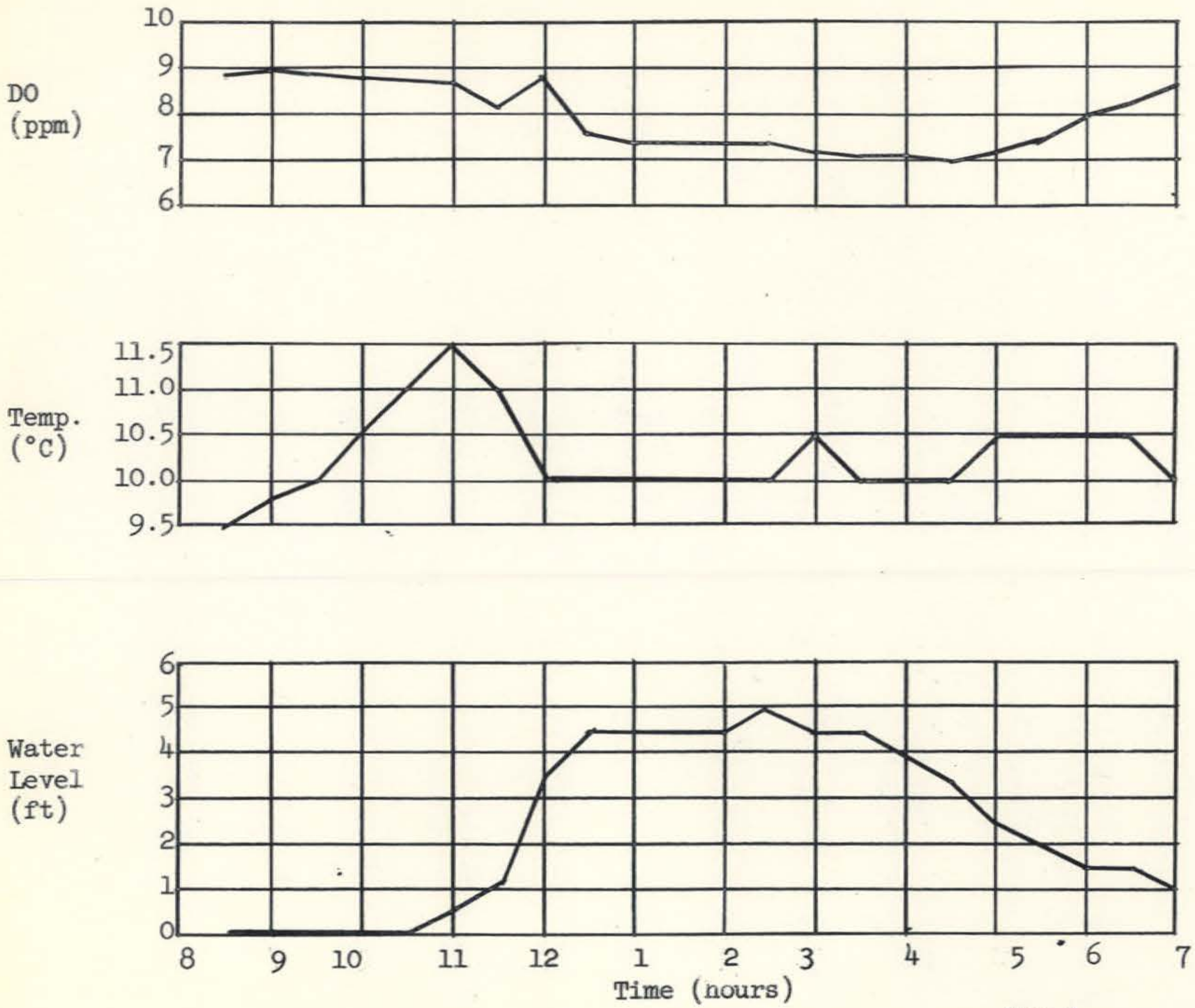


Run 1

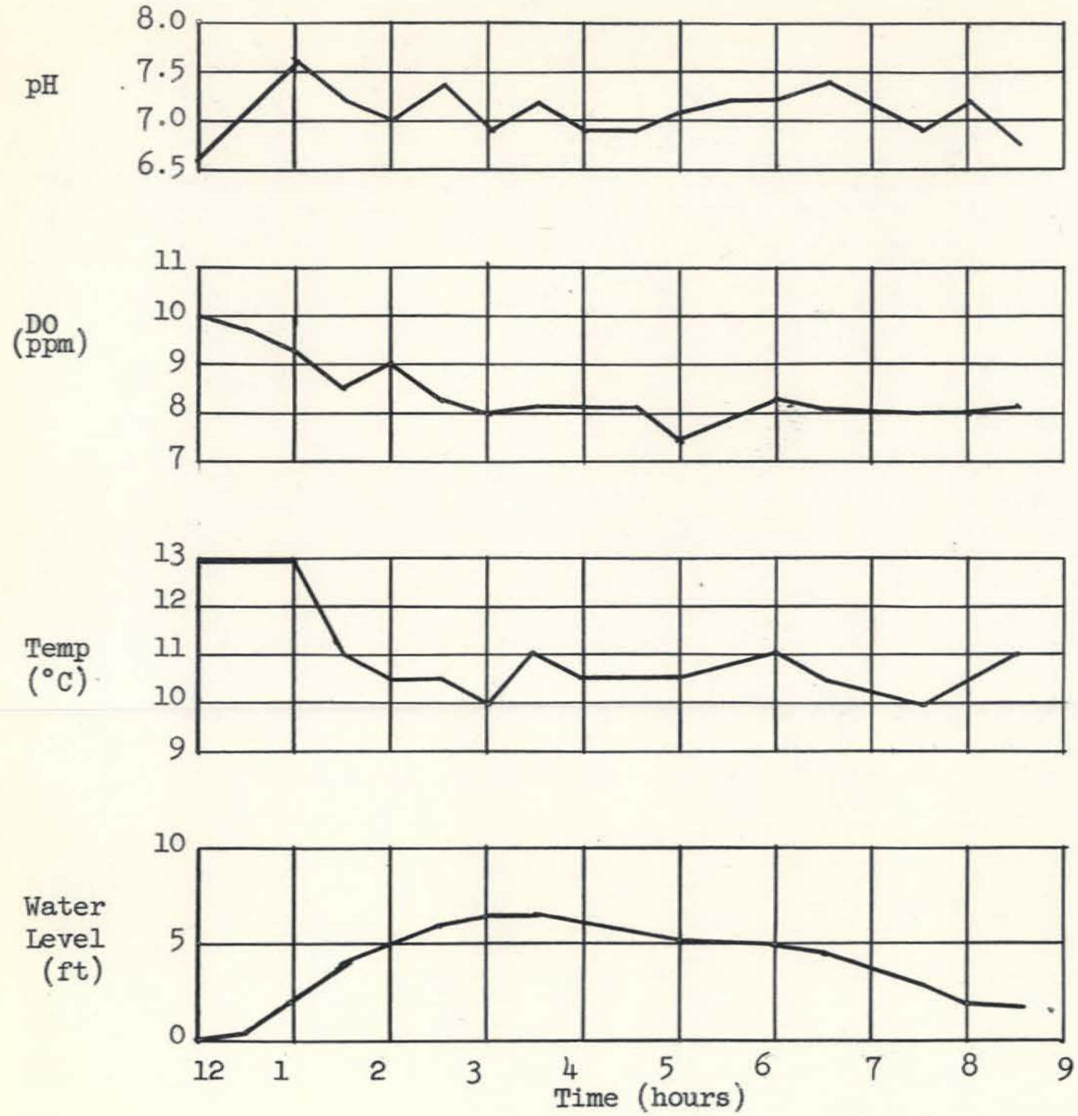
Station No. 1

July 1, 1958

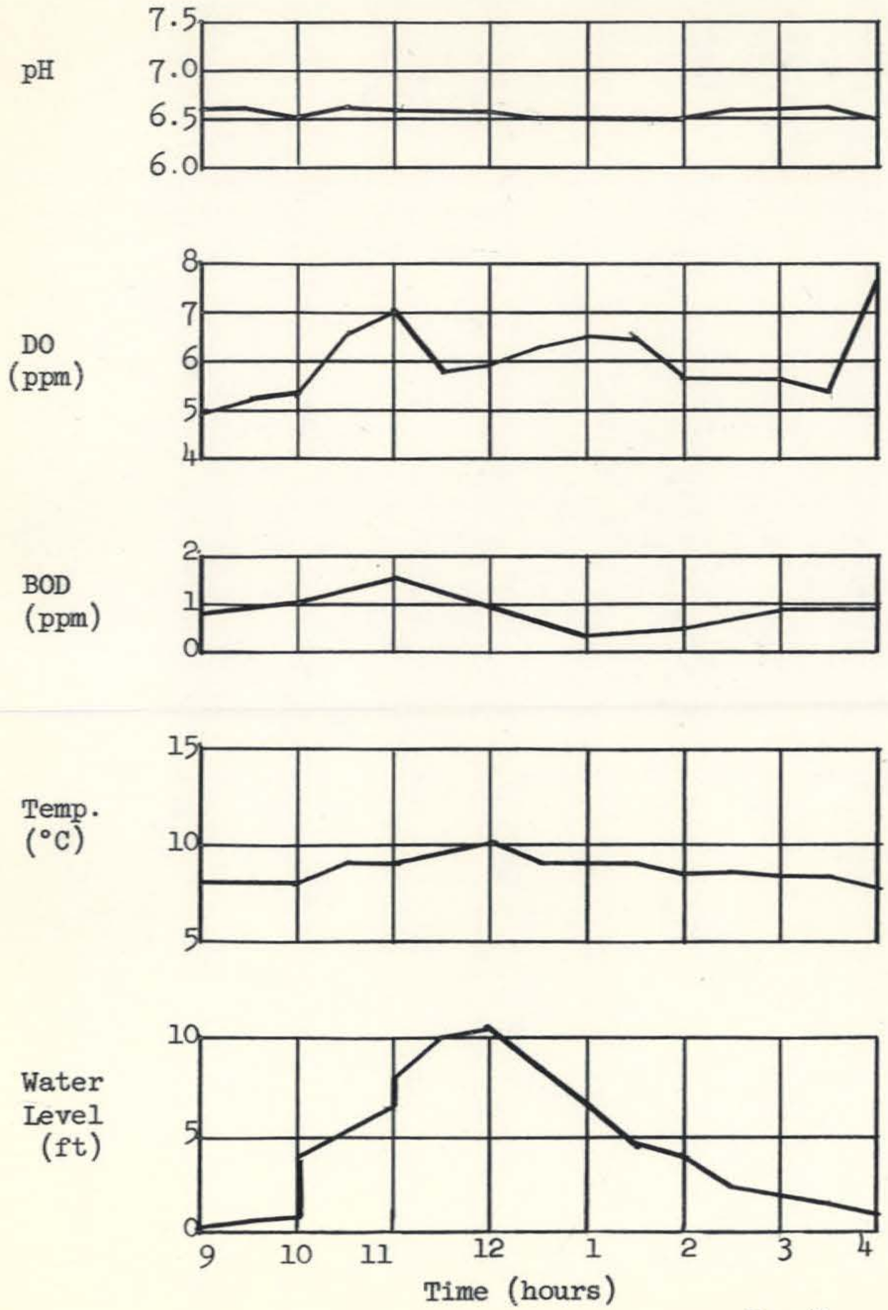
0.22 miles below Dam



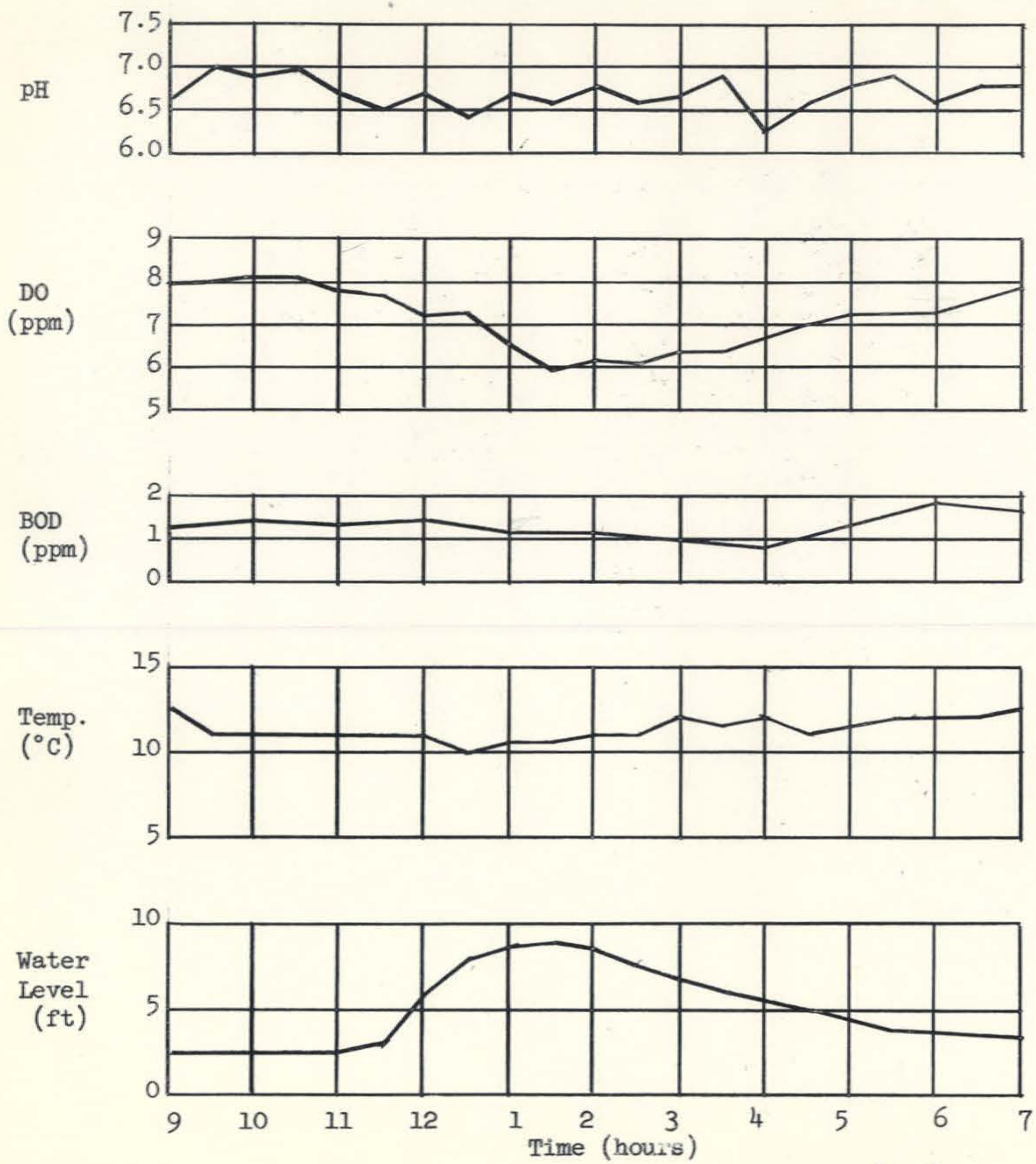
Run 1
Station No. 2
July 1, 1958
4.73 miles below Dam



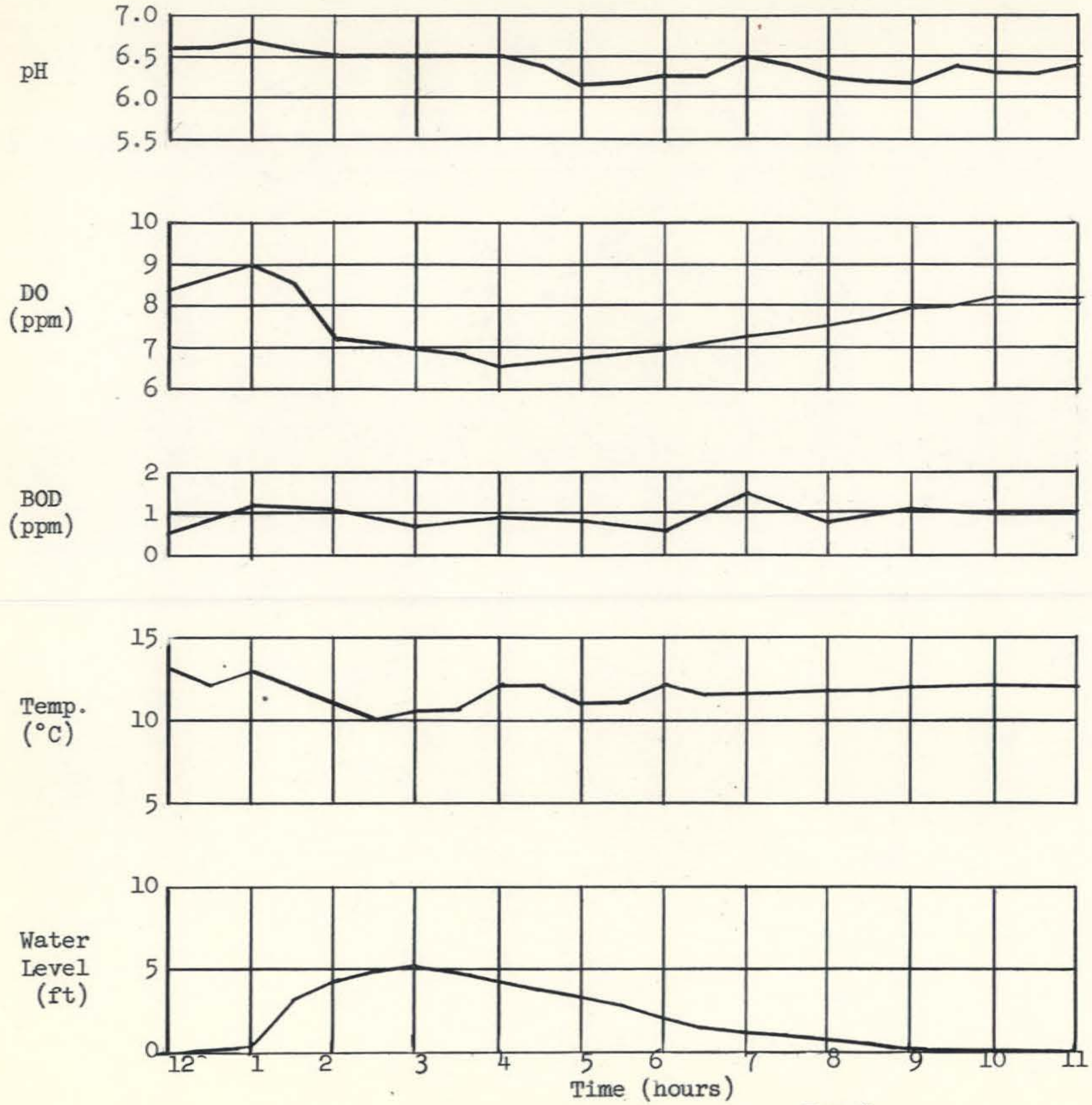
Run 1
Station No. 3
July 1, 1958
8.48 miles below Dam



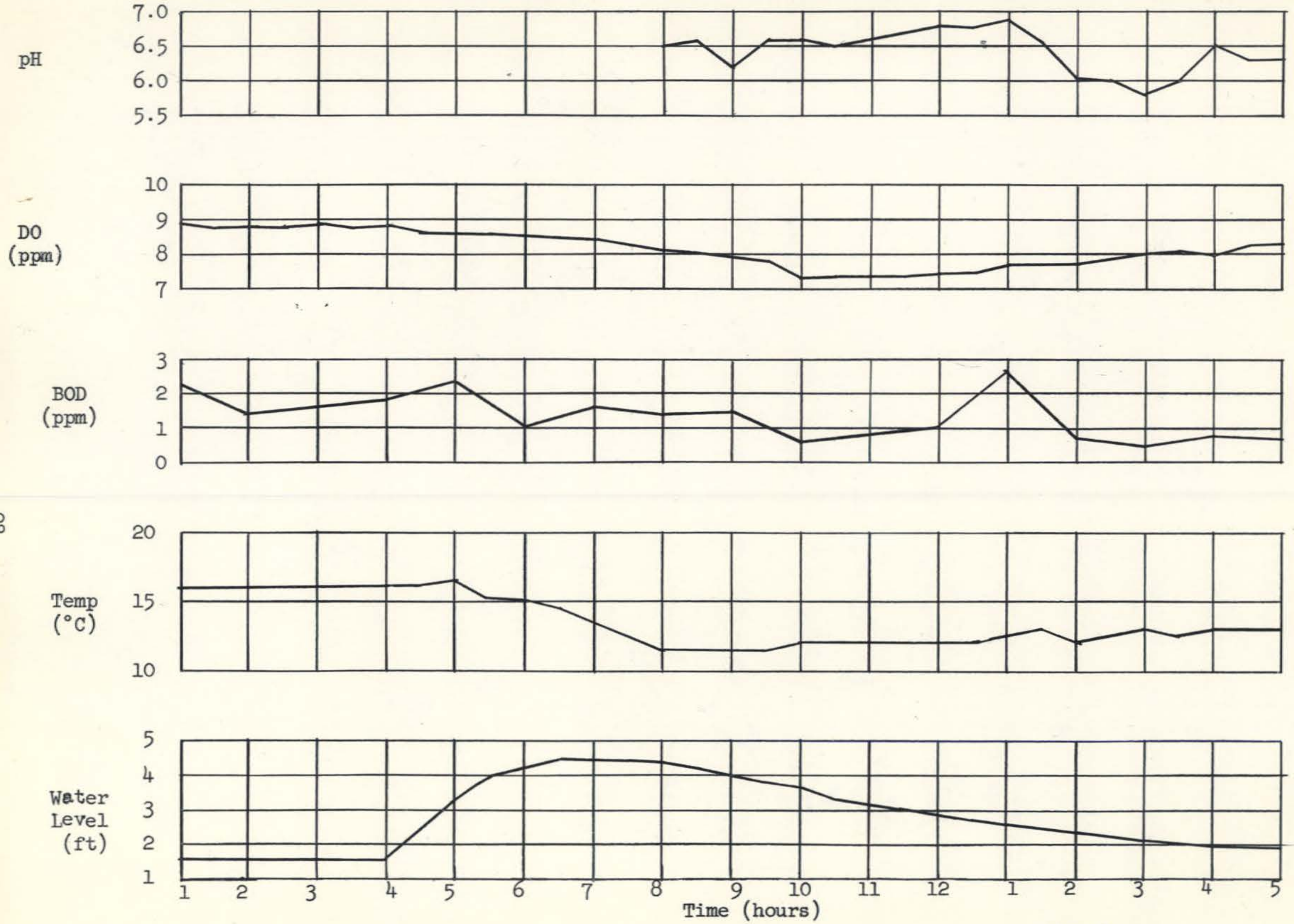
Run 2
Station No. 1
July 15, 1958
0.22 miles below Dam



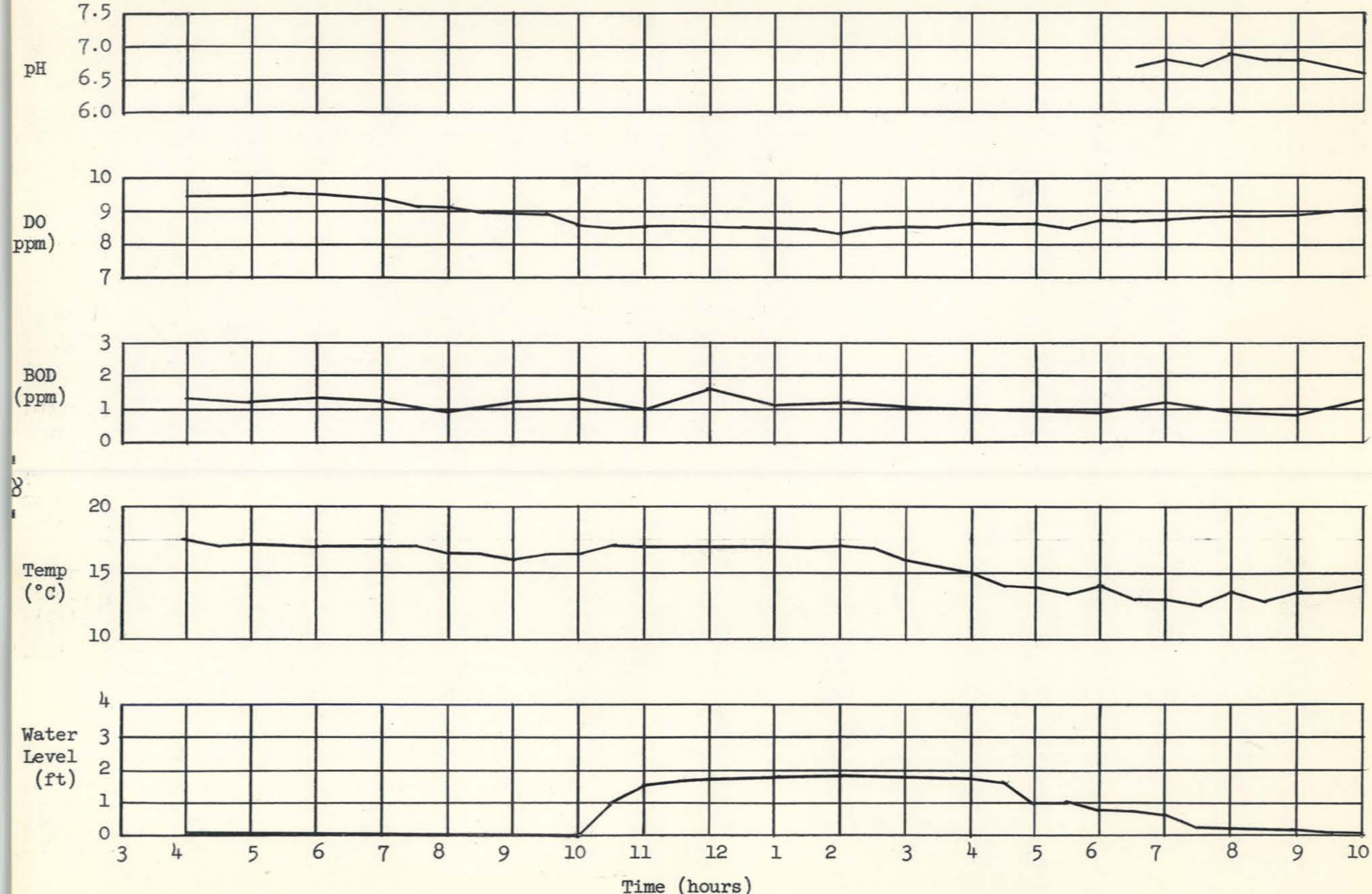
Run 2
Station No. 2
July 15, 1958
4.73 miles below Dam



Run 2
Station No. 3
July 15, 1958
8.48 miles below Dam



Run 2
Station No. 4
July 15, 1958
17.55 miles below Dam



Run 2
Station No. 5
July 15, 1958
31.03 miles below Dam